REMARKS

Applicants have amended their claims in order to further clarify the definition of various aspects of the present invention. Specifically, Applicants are adding new claims 13-26 to the application. Claims 13-15 respectively expressly set forth subject matter expressly set forth in claims 4-6, but are dependent respectively on claims 2, 13 and 14; and claims 16 and 17 respectively recite subject matter expressly set forth in claims 5 and 6, but are each dependent on claim 2. Claims 18 and 19, dependent respectively on claims 9 and 10, further define the water-soluble polymer, consistent with the description on pages 19 and 20 of Applicants' specification; and claims 20 and 21 define the weight-average molecular weight of the water-soluble polymer, consistent with descriptions on page 9 of Applicants' specification. Claims 22 and 23 further define the coefficient of kinetic friction; claims 24 and 25 further define Ubbelode's viscosity; and claim 26 further defines the point-of-inflection pressure, consistent with the descriptions on pages 10-12 of Applicants' specification.

Applicants respectfully submit that all of the claims present in the above-identified application patentably distinguish over the teachings of the reference applied by the Examiner in rejecting the claims in the Office Action mailed December 8, 2003, that is, the teachings of U.S. Patent No. 6,194,317 to Kaisaki, et al., under the provisions of 35 USC §102 and 35 USC §103.

It is respectfully submitted that this reference as applied by the Examiner would have neither taught nor would have suggested such a polishing medium, or such polishing method using such medium, wherein such medium includes, in

addition to an oxidizing agent, a metal-oxide-dissolving agent, and water, both a protective-film-forming agent and a water-soluble polymer. See claim 1.

In addition, it is respectfully submitted that this reference would have neither taught nor would have suggested such polishing medium as in the present claims, including wherein the water-soluble polymer has a weight-average molecular weight of 500 or more, as in claim 2, more specifically the weight-average molecular weight as in claims 20 and 21; and/or wherein the polishing medium has a coefficient of kinetic friction of 0.25 or more, as in claims 4 and 13, more particularly a coefficient of kinetic friction as in claims 22 and 23; and/or wherein the polishing medium has a Ubbelode's viscosity as in claims 5, 14 and 16, more particularly such viscosity as in claims 24 and 25; and/or wherein the polishing medium has a point-of-inflection pressure as in claims 6, 15 and 17, more particularly as set forth in claim 26.

Furthermore, it is respectfully submitted that the teachings of the applied reference would have neither disclosed nor would have suggested such polishing medium as in the present claims, having components as set forth in claim 1, and having additional features as in the remaining dependent claims, including (but not limited to) wherein the water-soluble polymer includes two or more polymers each having the weight-average molecular weight of 500 or more, but with weight-average molecular weights different from each other (see claim 3); and/or more specific materials for the oxidizing agent as in claim 7, and/or more specific materials for the metal-oxide-dissolving agent as in claim 8, and/or more specific materials for the protective-film-forming agent as in claim 9, particularly as in claim 10, and/or material of the water-soluble polymer as in claims 18 and 19; or wherein the medium

is used to polish a film which includes at least one of copper, a copper alloy, a copper oxide and a copper alloy oxide (see claim 12).

The present invention is directed to a polishing medium for chemical-mechanical polishing (CMP), and a polishing method making use of this medium, especially suited for polishing in forming wirings of semiconductor devices (for example, in polishing copper and copper-containing materials).

In order to obtain a flat polished surface using CMP, of a surface having hills and dales, with a polishing medium including, inter alia, a metal-oxide-dissolving agent and protective-film-forming agent, it is important to balance the effect attributable to the metal-oxide-dissolving agent and protective-film-forming agent used in the polishing medium. It is preferable to use a polishing medium which does not etch a metal film surface oxide layer in the dales, yet which the oxide layer has a high rate of polishing of the hills. In particular, it is preferable that the polishing rate is high, yet wherein the etching rate of the polishing medium is low.

Applicants provide a polishing medium which can form highly reliable buried metal film patterns in a good efficiency keeping a high CMP rate (that is, having a high polishing rate), and wherein the etching rate by the polishing medium is low. Applicants have found that by incorporating a water-soluble polymer in a polishing medium containing an oxidizing agent, a metal-oxide-dissolving agent, a protective-film-forming agent and water, the CMP rate can be made higher, while the etching rate is kept low. See page 7, lines 12-21 of Applicants' specification. Note also page 23, lines 5-20 of Applicants' specification. Thus, where a polishing medium for CMP which contains 1% by weight of benzotriazole (a protective-film-forming agent) is used, the film is usually polished only a little even when solid abrasive grains are

contained in the polishing medium. Moreover, where only a water-soluble polymer is mixed in the polishing medium for CMP and no protective-film-forming agent is included, it is difficult to control etching rate to be low. Through use of the combination of the protective-film-forming agent with the water-soluble polymer, as in the present invention, achievement of both a high CMP rate and a low etching rate is accomplished; and, moreover, through use of this combination of the protective-film-forming agent with the water-soluble polymer, it is not necessary to include solid abrasive grains in the medium.

In addition, as described on pages 8-12 of Applicants' specification, Applicants have found various characteristics of the water-soluble polymer and of the polishing medium as a whole, which enable achievement of much higher CMP rate, higher flattening, lower dishing level and lower erosion level. These characteristics are specific ranges for the weight-average molecular weight of the water-soluble polymer, the coefficient of kinetic friction of the polishing medium, the Ubbelode's viscosity of the polishing medium and the point-of-inflection pressure of the polishing medium. Note especially, page 8, line 23 to page 9, line 2; the paragraph bridging pages 9 and 10; page 11, lines 16-18; and the paragraph bridging pages 11 and 12, of Applicants' specification.

Attention is directed to the Examples and Comparative Examples; and, in particular, the results thereof, as seen in Tables 1-3 on pages 29 and 30 of Applicants' specification. It is respectfully submitted that the Examples and Comparative Examples in these tables constitute evidence in connection with showing unexpectedly better results achieved by the presently claimed subject matter, and must be considered when determining patentability. See In re

DeBlauwe, 222 USPQ 191 (CAFC 1984). Thus, in comparing the Examples with Comparative Examples 1-4, unexpectedly better results can be seen in decreased etching rate with improved CMP rate. Further unexpectedly better results are seen with molecular weight of the water-soluble polymer, point-of-inflection pressure, Ubbelode's viscosity and coefficient of kinetic friction, as in various of the present claims.

As will be shown in the following, it is respectfully submitted that the applied reference, Kaisaki et al., clearly does not anticipate, nor would have suggested, the presently claimed subject matter. However, even assuming, arguendo, that the teachings of Kaisaki et al. would have established a prima facie case of obviousness, the evidence of record clearly establishes unexpectedly better results achieved according to the present invention, thereby clearly supporting patentability of the presently claimed subject matter.

Kaisaki, et al. discloses a method of modifying or refining the surface of a wafer suited for semiconductor fabrication. The method includes a first step of contacting a second material of a wafer to a plurality of three-dimensional abrasive composites fixed to an abrasive article, the three-dimensional abrasive composites including a plurality of abrasive particles fixed and dispersed in a binder. A second step is relatively moving the wafer while the second material is in contact with the plurality of abrasive composites until the exposed surface of the wafer is planar and includes at least one area of exposed first material and one area of exposed second material. This patent further discloses that the second material is typically a metal, and that the first material is typically a dielectric material. See column 2, lines 37-60. Note also column 3, lines 57-65, describing, inter alia, that the second material can

be a conductive material which preferably includes metals such as tungsten, copper, aluminum, aluminum copper alloy, gold, silver or various alloys of these metals.

In column 4, lines 20-38 of Kaisaki, et al., in one embodiment, is disclosed a working liquid used with the abrasive article. This patent discloses that one useful working liquid is an aqueous solution that includes a variety of different additives, suitable additives including complexing, oxidizing, or passivating agents, surfactants, wetting agents, buffers, rust inhibitors, lubricants, soaps, or combinations of these additives. This patent discloses that the additives may also include agents which are reactive with the second material, e.g., metal or metal alloy conductors on the wafer surface, such as oxidizing, reducing, passivating, or complexing agents. Examples of oxidizing and complexing agents are also given. Note also column 7, lines 62-67. See also column 12, line 49 to column 15, line 57, providing a further description of the working liquid. One suitable working liquid is disclosed at column 15, lines 38-42, and includes a chelating agent, an oxidizing agent, an ionic buffer, and a passivating agent, these materials, inter alia, being hydrogen peroxide, water, $(NH_4)_2HPO_4$ $(NH_4)_3$ citrate and benzotriazole. Columns 18-22 of Kaisaki, et al. disclose formation of the abrasive article, wherein abrasive particles are dispersed in a binder in the article. Various precursor binders for the binder for binding the abrasive particles to the article are disclosed, which are described as curable organic material.

As seen from the foregoing, as well as from a full review of Kaisaki, et al., it is respectfully submitted that this reference does not discloses, nor would have suggested, a polishing medium as in the present claims, including, inter alia, the combination of both the protective film-forming agent and the water-soluble polymer.

Reference by the Examiner to binder precursors, on page 3 of the Office Action mailed December 8, 2003, as describing a water-soluble polymer forming part of the polishing medium in Kaisaki, et al., is respectfully traversed. It is respectfully submitted that the binder precursors constitute binders for forming the abrasive article, the abrasive article in Kaisaki, et al. including an exposed surface of a plurality of three-dimensional abrasive composites fixed and dispersed in a binder. It is respectfully submitted that the binder (not the binder precursor per se), after curing the binder precursor is part of the abrasive article, not the polishing medium including, inter alia, water, as in the present claims; and it is respectfully submitted that the teachings of Kaisaki, et al. would have taught away from the present invention, including the water-soluble polymer forming part of the polishing medium as in the present claims.

It is respectfully submitted that Kaisaki, et al., as applied by the Examiner, would have taught away from a water-soluble polymer as in the present claims. In this regard, it is emphasized that according to Kaisaki, et al., the acrylic acid and methacrylic acid are binder precursors, with the binder holding the abrasive particles. As can be appreciated by the Examiner, if the binder were of a water-soluble polymer, and used with a working liquid containing water, the binder would dissolve, thus not acting to fix and disperse the abrasive particles. Thus, clearly Kaisaki, et al. would have taught away from a water-soluble polymer, even as part of the abrasive article. Moreover, clearly Kaisaki, et al. would have neither taught nor would have suggested the polishing medium including, inter alia, the protective-film-forming agent, which also includes the water-soluble polymer, and advantageous effects

achieved thereby as shown in Applicants' original disclosure and as discussed in the foregoing.

Furthermore, Applicants respectfully traverse any conclusion by the Examiner on page 4 of the Office Action mailed December 8, 2003, that Kaisaki, et al. would necessarily result in a polishing medium having a molecular weight of the water-soluble polymer, a coefficient of kinetic friction, Ubbelode's viscosity, and a point-of-inflection pressure, as in various of the present claims, and advantages thereof. Clearly, a rejection under 35 USC §102 or under 35 USC §103 must be based on evidence. See In re McKellin, 188 USPQ 428 (CCPA 1976). Particularly in view of the advantages achieved according to the present invention, having various properties as recited in various of the present claims, the Examiner has clearly not established anticipation or obviousness of such aspects of the present invention. It is to be noted that Kaisaki, et al. discloses many different materials for the working liquid described therein, and it is respectfully submitted that the Examiner has clearly not established inherency of molecular weight of the water-soluble polymer, or coefficient of kinetic friction, Ubbelode's viscosity, and/or point-of-inflection pressures, of the liquid medium, as in the present claims.

In view of the foregoing comments and amendments, reconsideration and allowance of all claims presently in the application, are respectfully requested.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Antonelli, Terry, Stout & Kraus, LLP Deposit Account No. 01-2135 (Docket No. 566.41259X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By 
William I. Solomon
Reg. No. 28,565

1300 North Seventeenth Street, Suite 1800
Arlington, Virginia 22209
Telephone: (703) 312-6600
Facsimile: (703) 312-6666
WIS/sjg